

# The Psychometric Properties of the Clock Drawing Test in South Korea

SANG-HEON LEE, OT, PhD<sup>1)</sup>

<sup>1)</sup> Department of Occupational Therapy, College of Medical Science, Soon Chun Hyang University:  
646 Eupnae-ri, Shinchang-myeon, Asan-si, Chungnam 336-745, Republic of Korea

**Abstract.** [Purpose] The aims of the present study were to analyze the validity and reliability of the Clock Drawing Test (CDT) as a screening tool for cognitive impairments in both stroke patients and older adults in South Korea. [Subjects and Methods] Forty-three stroke patients and 42 elderly residents living in urban communities were recruited. They were divided into three groups according to K-MMSE scores. Kruskal-Wallis one-way ANOVA was used for construct validity, Friedman two-way ANOVA for discriminative validity, and Spearman's rank order correlation coefficient for inter-rater reliability. [Results] Regardless of groups, construct and discriminative validity tests showed statistically significant results, and Spearman's rho was over 0.56. [Discussion] CDT demonstrated acceptable validity and reliability. CDT using the productive methods and Freedman's scoring systems may be suitable for cognitive decrease in stroke patients and the elderly.

**Key words:** Clock Drawing Test, Reliability, Validity

(This article was submitted Dec. 10, 2013, and was accepted Feb. 7, 2014)

## INTRODUCTION

Early detection of cognitive impairment is an issue of growing importance in South Korea. This interest comes at a time of rapid growth in the elderly population. This growth has in turn caused an increase in related pathological conditions, such as dementia. Therefore, there is a need for a simple, inexpensive, objective, accurate, and quick to administer neuropsychological test that requires few materials<sup>1)</sup>.

The Mini-Mental State Examination (MMSE) may be preferable for detecting cognitive impairment; however, it takes 15 to 20 minutes to administer, does not reflect visuoconstructive dysfunction, and relies on verbal ability<sup>1)</sup>. In South Korea, the MMSE was translated into Korean, and age- and education-specific norms for the Korean Mini-Mental State Examination (K-MMSE) have been presented along with cut-off scores for screening dementia<sup>2)</sup>.

The Clock Drawing Test (CDT) is a cognitive impairment screening tool consisting of a variety of performance and scoring methods, most of which are fairly easy to use<sup>3)</sup>. It is quicker and easier to use than the MMSE, and requires several cognitive functions (memory, verbal understanding, abstract thinking, spatial knowledge, planning, concentration, executive function, and visuoconstructive skill) for its successful completion<sup>1, 4, 5)</sup>. Moreover, unlike the MMSE,

the CDT does not require verbal abilities.

The CDT was translated into Korean following its introduction into South Korea, and its clinical use has recently increased. Several clinicians and researchers working with schizophrenia, stroke, traumatic brain injury, Alzheimer's-related dementia, and the elderly have published studies using the CDT<sup>6, 7)</sup>. However, no consensus has yet been reached regarding the most appropriate methods for clinical applications of the CDT.

The CDT was designed outside South Korea. Before the CDT can be used, translation and psychometric measures are required. However, there is not enough literature related to the psychometric properties and clinical utility of the CDT in South Korea. Therefore, this study investigated the psychometric characteristics of the CDT with using the productive method and the quantitative scoring method of Freedman et al<sup>7)</sup>.

## SUBJECTS AND METHODS

This study was approved by the Institutional Review Board of Soonchunhyang University. All participants provided their informed consent before participating in the experiment. Initially, 61 stroke patients and 55 elderly individuals living in urban communities in South Korea were recruited. Exclusion criteria included suffering from aphasia, or hearing or vision impairments that would have interfered with the participant's ability to be accurately assessed.

The CDT consists of three subtests with different drawing conditions: free-drawn, pre-drawn, and examiner clock. The participants drew a round analog clock on a blank piece of paper (210 mm × 297 mm) for the free-drawn condi-

Corresponding author. Sang-Heon Lee (E-mail: sangheon@sch.ac.kr)

©2014 The Society of Physical Therapy Science. Published by IPEC Inc.  
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License <<http://creativecommons.org/licenses/by-nc-nd/3.0/>>.

tion, a 10-cm diameter pre-drawn circle for the pre-drawn condition, and a 10-cm circle and digits pre-drawn for the examiner clock condition. Participants were instructed to draw hands on the clock to indicate to the time of 6:45, 6:05, and 11:10 for each condition. Participants were not allowed to consult another clock for guidance. Scoring system of Freedman et al.'s was used for quantitative rating, since this system uses detailed items that test components of round, drawn clocks. The maximum possible score is 15 points and higher scores indicate that cognitive function is well preserved.

Two occupational therapists and three university students collected the data. The elderly were assessed in their homes by the students, while the stroke patients were assessed by occupational therapists in the hospital. The K-MMSE and the CDT were administered on week days, separated by a one week interval. The results were blinded between the researcher and the occupational therapists. Co-rating sessions were performed by two trained university students at a different location to ensure inter-rater reliability.

SPSS version 20.0 was used for the statistical analyses. Construct validity was tested by Kruskal-Wallis one-way ANOVA, and discriminative validity was tested by Friedman two-way ANOVA. Inter-rater reliability was analyzed by Spearman's rank order correlation coefficient.

## RESULTS

Data from 85 participants (43 stroke patients and 42 elderly) were analyzed in this study. General demographic in-

formation including age, gender, and education are shown in Table 1. The construct validity of the CDT was statistically significant for the stroke patients and the elderly divided according to K-MMSE scores for dementia screening in South Korea ( $p < 0.05$ ; Table 2). Discriminative validity was also found to be statistically significant for the three different drawing conditions ( $p < 0.01$ ; Table 3). Spearman's rho for inter-rater reliability was over 0.56 ( $p < 0.05$ , Table 4).

**Table 1.** General characteristics of the subjects

		Stroke (N=43)		Elderly (N=42)	
		No	%	No	%
Sex	Male	30	69.8	29	70.7
	Female	13	30.2	12	29.3
	60-64	24	55.8	11	26.8
Age (years)	65-69	3	7.0	6	14.6
	70-74	10	23.3	7	17.1
	75-79	6	14.0	5	12.2
	80-84			10	24.4
	≥85			2	4.9
Education level	No education	3	7.0		
	1-3 years	2	4.7	3	7.3
	4-6 years	5	11.6	27	65.9
	7-9 years	4	9.3	11	26.8
	10-12 years	14	32.6		
	≥13 years	15	34.9		

**Table 2.** The construct validity of the CDT

		K-MMSE <sup>a</sup>		
		≥ 25	< 25, ≥ 21	< 21
Stroke	Free-drawn condition <sup>**</sup>	12.5 ± 2.0 <sup>b</sup> (N=23)	11.0 ± 4.2 (N=9)	6.6 ± 5.1 (N=11)
	Pre-drawn condition <sup>**</sup>	11.0 ± 1.7 (N=23)	9.9 ± 3.7 (N=9)	5.6 ± 4.1 (N=11)
	Examiner clock condition <sup>**</sup>	9.3 ± 2.1 (N=23)	5.9 ± 4.1 (N=9)	5.3 ± 4.1 (N=11)
Elderly	Free-drawn condition <sup>*</sup>	14.0 ± 1.0 (N=15)	12.3 ± 1.4 (N=17)	10.7 ± 0.6 (N=9)
	Pre-drawn condition <sup>*</sup>	12.5 ± 3.3 (N=18)	11.4 ± 1.9 (N=26)	9.9 ± 1.9 (N=9)
	Examiner clock condition <sup>**</sup>	8.3 ± 6.0 (N=18)	9.0 ± 4.1 (N=26)	6.0 ± 4.5 (N=9)

<sup>a</sup>, Korean -Mini Mental State Examination; <sup>b</sup>, Mean ± SD; \*,  $p < 0.05$ , \*\*,  $p < 0.01$

**Table 3.** The discriminative validity of the CDT

	CDT		
	Free-drawn condition	Pre-drawn condition	Examiner clock condition
Stroke (N=43) <sup>**</sup>	10.7 ± 4.1 <sup>a</sup>	9.4 ± 3.5	7.6 ± 3.6
Elderly (N=41) <sup>**</sup>	12.3 ± 4.1	11.2 ± 2.7	9.4 ± 3.0

<sup>a</sup>, Mean ± SD; \*\*,  $p < 0.01$

**Table 4.** The inter-rater reliability of the CDT

		CDT		
		Free-drawn condition	Pre-drawn condition	Examiner clock condition
Stroke	≥ 25 <sup>a</sup> (N=13)	0.93 <sup>**</sup>	0.73 <sup>**</sup>	0.75 <sup>**</sup>
	< 25, ≥ 21 (N=9)	0.97 <sup>**</sup>	0.68 <sup>*</sup>	0.99 <sup>**</sup>
	< 21 (N=11)	0.98 <sup>**</sup>	0.96 <sup>**</sup>	0.92 <sup>**</sup>
Elderly	≥ 25 (N=18)	0.59 <sup>*</sup>	0.56 <sup>*</sup>	0.73 <sup>**</sup>
	< 24, ≥ 21 (N=26)	0.64 <sup>**</sup>	0.57 <sup>*</sup>	0.83 <sup>**</sup>
	< 21 (N=10)	0.91 <sup>**</sup>	0.84 <sup>**</sup>	0.89 <sup>**</sup>

<sup>a</sup>, MMSE-K score; \*,  $p < 0.05$ ; \*\*,  $p < 0.01$

## DISCUSSION

The perfect scale for screening for cognitive deterioration should be quick and easy to administer. Furthermore, it should be applicable to the entire dementia disorder spectrum and discriminate reliably between individuals with and without dementia, independent of the rater. Multiple scales are often used in dementia screenings. Both the MMSE and the CDT are scales often used for screening.

This study measured the psychometric validity of the CDT as an objective and accurate screening test, because few such studies have been conducted on the CDT in South Korea and there is relatively little information available for the CDT compared to the K-MMSE. Kruskal-Wallis one-way and Friedman two-way ANOVA gave statistically significant  $t$  results ( $p < 0.05$ ), and Spearman's correlation coefficient ranged from 0.56 to 0.99, showing the validity of the CDT when using productive performance and the quantitative scoring method of Freedman et al.'s to screen stroke patients and the elderly.

There are various testing and scoring systems for the CDT, but none are universally accepted. More complex scoring systems require specific rating skills, which increases training time<sup>5)</sup>. The occupational therapists in the present research did not receive special training in the detailed interpretation of the test. Our study utilized simple the scoring method of the Freedman et al.<sup>8)</sup>, which has previously used by occupational therapists and other researchers in South Korea<sup>3)</sup>.

Regardless of rater, this study found the CDT to be a quick and easy face-to-face screening tool for discriminat-

ing between mild, moderate, and severe cognitive impairments in stroke patients and the elderly living in urban communities. Further, the three subtests of the CDT can be used according to the severity of cognitive impairment. Future studies should extend the use of this instrument to other populations and find appropriate administration and scoring methods for subjects' diagnoses and clinical settings.

## ACKNOWLEDGEMENT

This work was supported by the Soonchunhyang University Research Fund.

## REFERENCES

- 1) Schramm U, Berger G, Müller R, et al.: Psychometric properties of Clock Drawing Test and MMSE or Short Performance Test (SKT) in dementia screening in a memory clinic population. *Int J Geriatr Psychiatry*, 2002, 17: 254–260. [Medline] [CrossRef]
- 2) Kang YW: A normative study of the Korean-Mini Mental State Examination in the elderly. *Korean J Psychol*, 2006, 25: 1–12.
- 3) Lee SH, Lee SA, Park SY: The reliability and validity of clock drawing test. *J Korean Acad Occu Ther*, 2011, 19: 89–100.
- 4) Kørner EA, Lauritzen L, Nilsson FM, et al.: Simple scoring of the Clock-Drawing test for dementia screening. *Dan Med J*, 2012, 59: A4365. [Medline]
- 5) Kim BY: Preliminary study for expanding the clinical utility of clock drawing test, Seoul: Sungshin Women's University, 2003.
- 6) Nishiwaki Y, Breeze E, Smeeth L, et al.: Validity of the Clock-Drawing Test as a screening tool for cognitive impairment in the elderly. *Am J Epidemiol*, 2004, 160: 797–807. [Medline] [CrossRef]
- 7) Choi SJ, Kook SH: The response of the clock drawing test in patients with traumatic brain injury. *Korean J Clin Psychol*, 2005, 24: 225–241.
- 8) Freedman M, Leach L, Kaplan E, et al.: Clock drawing: a neuropsychological analysis, Oxford University Press, 1994.